



Satellite Constellation Evolution

Session 5.0

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NOAA's Flagship Satellites

- NOAA uses satellites to gather data to monitor and understand our dynamic planet
- The NOAA Satellite and Information Service (NESDIS) provides timely access to global environmental data from satellites and other sources to monitor and understand our dynamic Earth. We manage the Nation's operational environmental satellites and deliver data and information services such as Earth system monitoring and official assessments of the environment



<u>JPSS*</u>	<u>GOES-R Series*</u>
Provides Global coverage twice daily	Earth imager for enhanced weather, ocean, land and hazard products
Atmospheric temperature and moisture observations	Rapid coverage of global and focused areas
Tracks the health of the ozone layer and measures ozone in the atmosphere	Lightning Mapper
Night time imagery for polar viewing	Measures the space environment magnetic field

*JPSS-1 Launch Date
12 October 2017

JPSS and GOES are the Major NOAA Programs of Record

*GOES-R Launched
19 November 2016

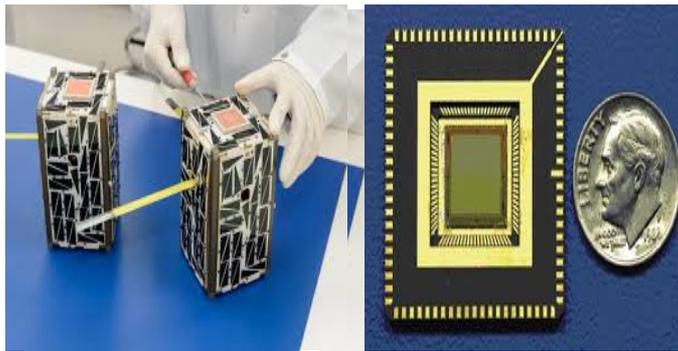


Why Evolve?

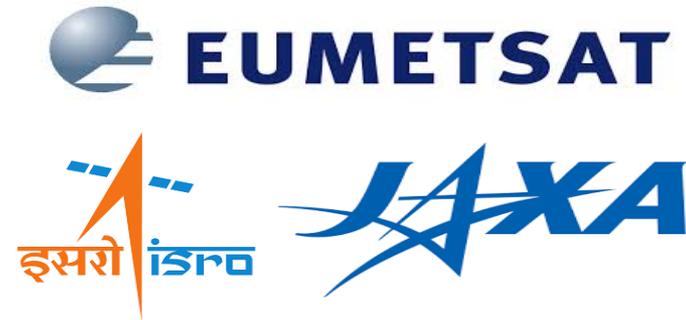
Requirements Change



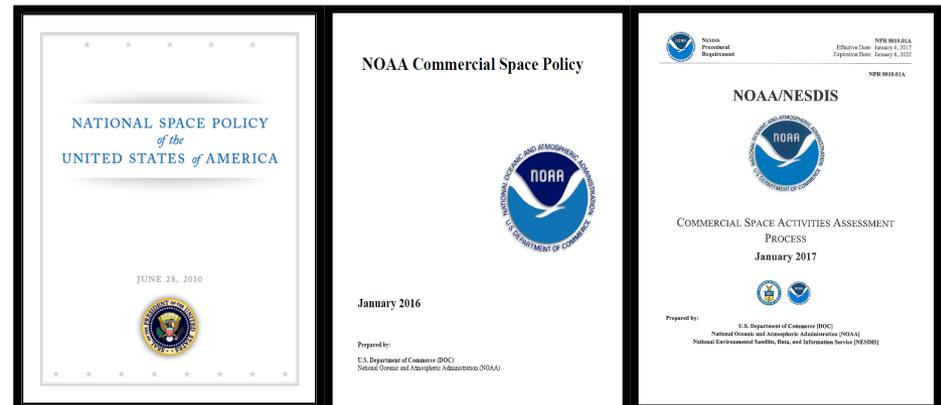
Technology Advances



Partners Adjust Plans



Policies Change





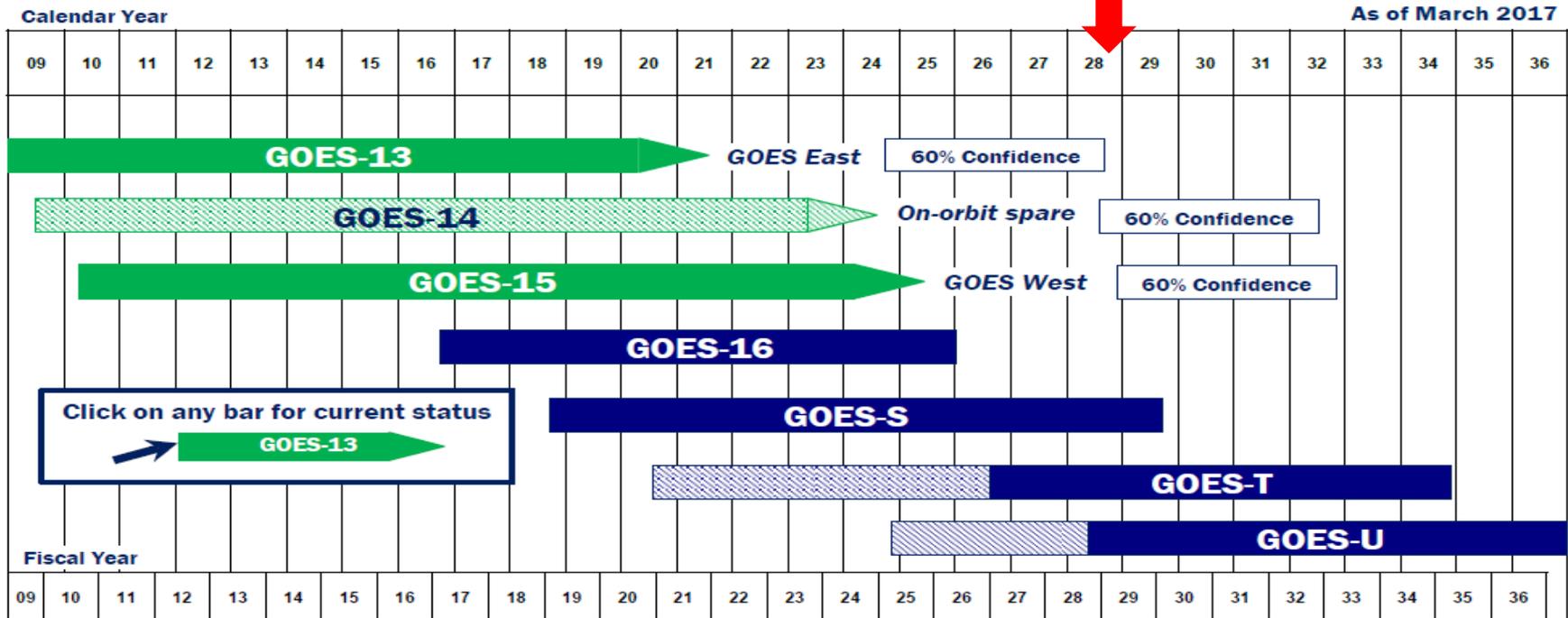
Dynamic Global Space-Based Observing System





Why Start Now?

NOAA Geostationary Satellite Programs Continuity of Weather Observations

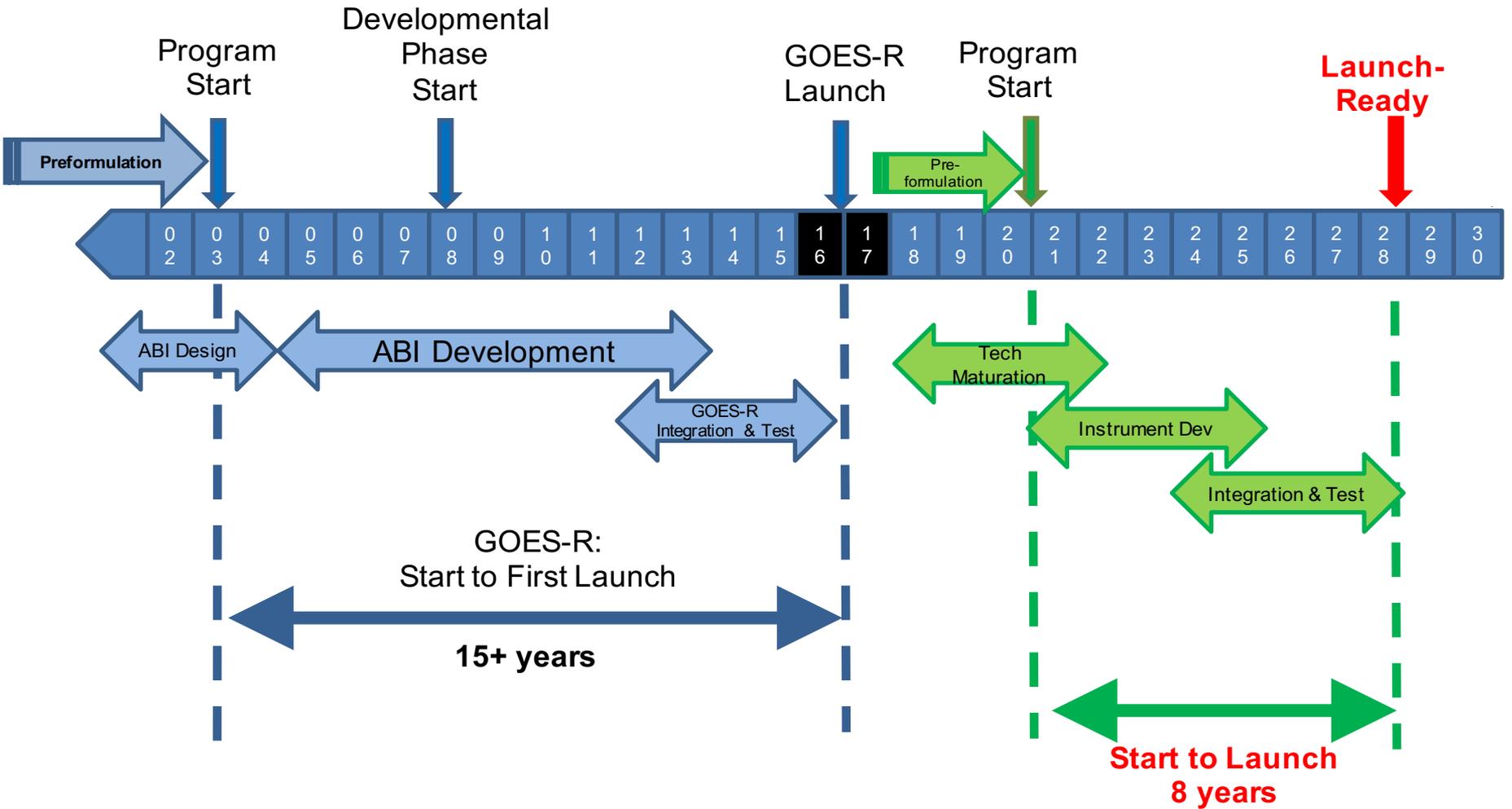


Approved:
 Assistant Administrator for Satellite and Information Services

	In orbit, operational		Planned in-orbit Storage
	In orbit, storage		Planned Mission Life
	Reliability analysis-based extended weather observation life estimate (60% confidence) for satellites on orbit for a minimum of one year -- Most recent analysis: March 2017		



Why Start Now?





NESDIS is Architecting the Future

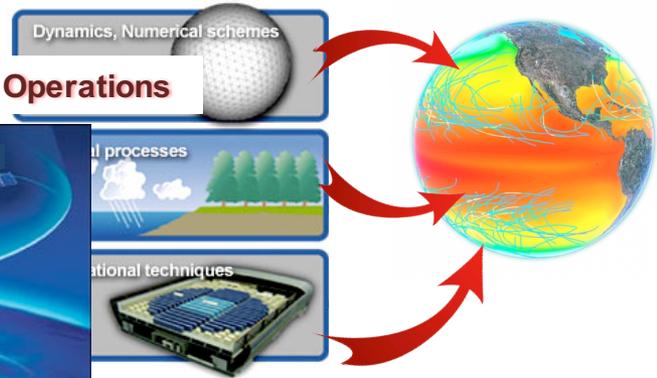
Develop a space-based observing enterprise that is flexible, responsive to evolving technologies, and economically sustainable.
--FY15 NOAA Annual Guidance

Global Earth Observing Satellite System



Next Generation Observations

Integrated & Assimilated Operational Data Flow



Data and models meet user needs

Next Generation Integrated & Adaptive Ground Operations



Integrated Operations and Data Management System



How is NESDIS Approaching This?



- How to Find Balance: Capability, Cost, New Technology, Continuity?
 - NOAA Satellite Observing System Architecture (NSOSA) Study
- How to Fuse More Sources?
 - Enterprise Systems Engineering
 - Enterprise Ground Architecture
 - Transparency
- How to Effectively Engage with New Entrants?
 - Commercial Space Activities



NOAA Space Architecture



Mission Drives Architecture Requirements

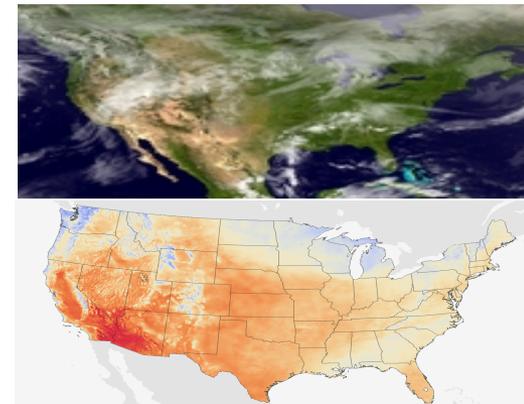
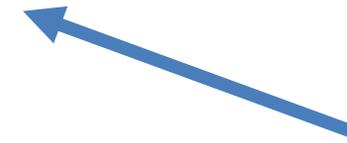


Observations result in warnings, watches, baseline weather and space weather forecasts, and ocean or fisheries actions



User Prioritized Requirements:

- National Weather Service (NWS)
- National Marine Fisheries Service (NMFS)
- National Ocean Service (NOS)
- Office of Oceanic and Atmospheric Research



Observations Driven by Requirements	
Performance	Assurance
Phenomena	Reliability
Accuracy/Precision	Timely
Resolution Time & Space	No Capability Gap ¹⁰





EDR Value Model Objectives



Terrestrial / Ocean Objectives

3-D winds
Real Time (RT) regional Weather imagery
Global GNSS-RO soundings
Global RT imagery
Global Near RT microwave (MW) soundings
Global Near RT IR soundings
Global ocean surface vector winds
Non-RT global Weather imagery
Global ocean color/phytoplankton composition
Microwave imagery
Lightning
Radar-based global precipitation rates
Regional MW soundings
Regional infrared (IR) soundings
Global sea surface height
Global chemical concentration
Ozone
Outgoing Long Wave Radiation - NASA Mission
Incoming solar radiation - NASA Mission

Space Weather Objectives

Coronagraph imagery: Off Sun-Earth line
Coronagraph imagery: Sun-Earth line
Photospheric magnetogram imagery: Off Sun-Earth line
Heliospheric images
Auroral imaging
Thermospheric O/N2 ratio (height integrated)
Upper thermospheric density
Ionospheric electron density profiles
Interplanetary Solar wind: Off Sun-Earth line
Photospheric magnetogram imagery-Sun-Earth line
Solar X-ray irradiance
Solar EUV imaging
Solar EUV irradiance
Interplanetary Solar wind: Sun-Earth Line
Interplanetary Energetic particles
Geospace Energetic particles
Geomagnetic field
Interplanetary Magnetic Field



EDR Value Model Objectives



Strategic Objectives

Assurance of Core Capabilities

Compatibility with stable budgets

Assurance of all capabilities

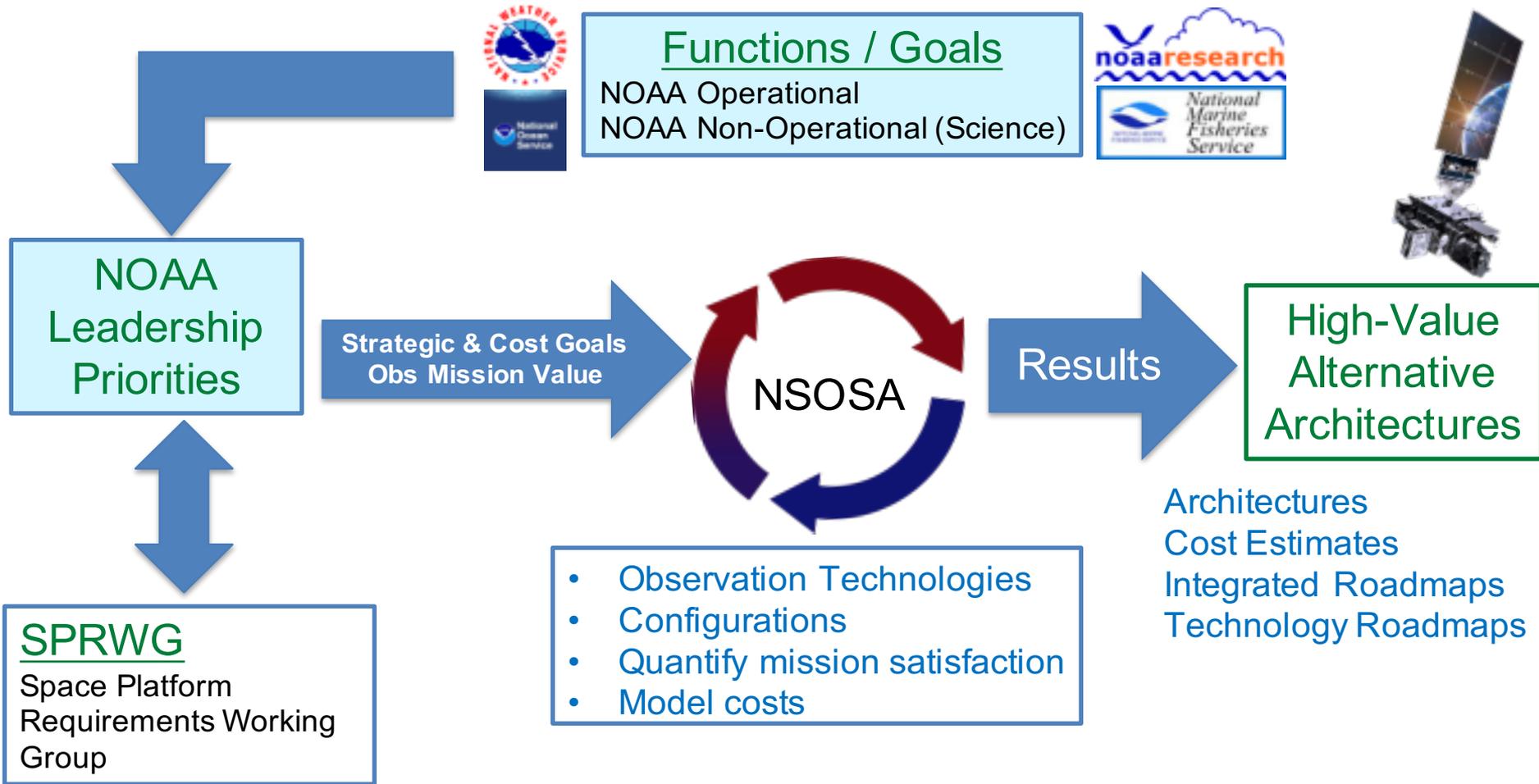
Programmatic Responsiveness and Adaptability

Develop and Maintain International Partnerships

Low Risk at Constellation Level



Study Methodology



NOAA Leadership Priorities

SPRWG
Space Platform Requirements Working Group

Strategic & Cost Goals
Obs Mission Value

Functions / Goals
NOAA Operational
NOAA Non-Operational (Science)



- Observation Technologies
- Configurations
- Quantify mission satisfaction
- Model costs

Results

High-Value Alternative Architectures

Architectures
Cost Estimates
Integrated Roadmaps
Technology Roadmaps





Planning for the Future

NOAA User Prioritized Requirements

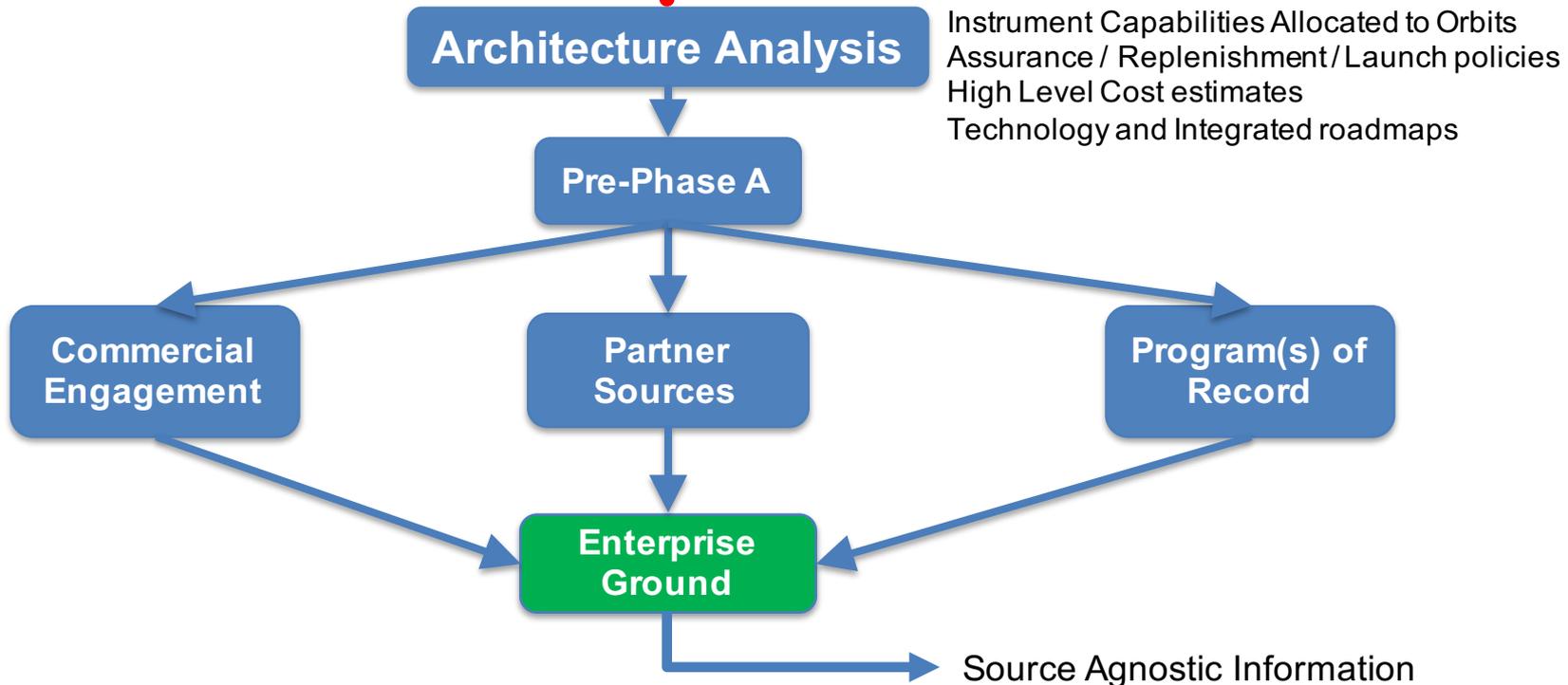
Strategic
Priorities

National Weather Service
National Marine Fisheries Service
National Ocean Service
Office of Oceanic and Atmospheric Research

Operational
Considerations
(NOAA/DoD/
Partners)

Policies &
Standards

Technology
Opportunities





NOAA Commercial Weather Data



Continuously Explore Options NOAA Policy Framework



NOAA Commercial Space Policy



January 2016

Prepared by:
U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)

“NOAA will explore and, where appropriate, **pursue demonstration projects** to validate the viability of assimilating commercially provided environmental data and data products into NOAA meteorological models and add value to the forecast.”



NESDIS
Procedural
Requirement

NPR 8010.01A
Effective Date: January 6, 2017
Expiration Date: January 6, 2022

NPR 8010.01A

NOAA/NESDIS



COMMERCIAL SPACE ACTIVITIES ASSESSMENT
PROCESS
January 2017



Prepared by:
U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)

“NESDIS will issue one or more solicitations...for NOAA to **acquire and evaluate on-orbit observations from commercial sources**, where industry has or will establish on-orbit capabilities that were identified by NOAA as promising option(s)...”

Meeting Mission Objectives With All Available Options



Continuously Explore Options - NESDIS Commercial Space Assessment Process



- Process includes:
 - Analyze gaps in ability to meet requirements
 - Regularly canvass commercial sector
 - Pursue demonstration projects where appropriate
 - Given promising demonstration, enter into contracts for operational data buys
- Assessment Criteria – mission specific, but cover:

<u>Value</u>	<u>Cost Effectiveness</u>	<u>Exploitability</u>
Concept Legitimacy	Cost/value balance	Comprehensiveness
Accuracy	Availability	Security
Quality	Sustainability	Downstream use
Timeliness	Support	
Reliability		
Validity		

Codifies the Approach to Assessing New Commercial Capabilities



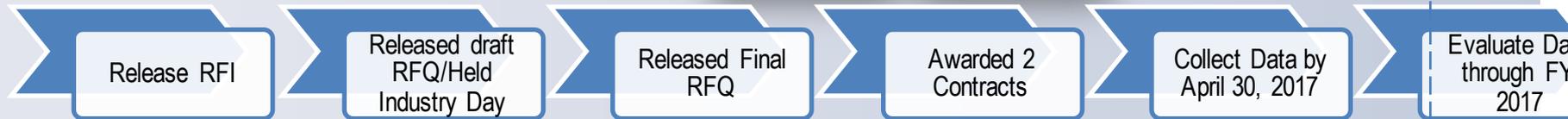
Continuously Explore Options - Commercial Weather Data Pilot



Win-win for both NESDIS and the commercial sector

- NOAA is learning about existing commercial capabilities and developing our processes for purchasing commercial data in the future
- Companies are gaining a trial run of the NOAA evaluation process and data evaluation results

FY16 \$3M
Round 1



FY17 \$5M
Round 2





Thank You!



- Must must start now on what comes after JPSS and GOES-R series
- The dynamic technology, commercial, and partner environment drives us to consider options
- We are completing a quantitative analysis to inform NOAA decisions
- We are developing NESDIS capability to expand our data sources and business models



BACKUP



Continuously Explore Options

How to Engage with Private Industry? [3]



- NESDIS has held regular workshops open to the public:
 - April 2015: Overview of NOAA's approach to working with the commercial sector
 - December 2015: Discussion of the content of the NESDIS Commercial Space Activities Assessment Process
 - July 2016: Industry Day focused on Commercial Weather Data Pilot Round 1 draft Request for Quotation for radio occultation data
- The NESDIS Process states that NESDIS will sponsor periodic meetings or workshops to facilitate communication among NESDIS, the scientific community and the private sector
- NOAA and NESDIS have identified entry points for commercial sector engagement
 - The NOAA Policy names the Office of Space Commerce as the entry point for engagement with NOAA
 - The NESDIS Process names the NESDIS Office of System Architecture and Advanced Planning as the entry point for NESDIS

A key tenet in the Satellite Constellation Evolution and transition to the future is to engage with new entrants in the commercial space enterprise.



OSAAP Mission and Vision



Mission: OSAAP manages NESDIS' architecture and advanced planning efforts to deliver sustainable, robust, and adaptive systems and services that meet its customer needs

Vision: OSAAP is a strategic organization that develops and sustains an Enterprise mission capability enabling NESDIS to work as an efficient team in a consistent rigorous framework

